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Temporal and identity prediction in visual-auditory events: Electrophysiological evidence from stimulus omissions

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Introduction

A rare omission of a sound that is predictable by anticipatory visual information or self-generated motion induces an early negative omission response at around 45-100 ms (oN1) and subsequent mid- and late latency omission responses (oN2, oP3) in the EEG during the period of silence where the sound was expected.^[1,2]

It was previously suggested that such omission responses are primarily driven by the identity of the anticipated sound.^[3] Here, we examined the role of *temporal* prediction in conjunction with *identity* prediction in the evocation of the auditory oN1, oN2 and oP3.

A video of an actor performing a single hand clap (Figure 1) containing reliable anticipatory information about both the identity and onset of the sound served as a reference condition.

In two additional conditions, we varied either the auditory onset (relative to the visual onset) or the identity of the sound across trials in order to hamper temporal and identity predictions.

Regular visual-auditory trials were interspersed with unpredictable sound omissions. Neural activity associated with visual-to-auditory predictions was acquired from these *silent* trials.

Method

Participants
N = 27 (23 female, all neurotypical)
Mean age 19.93 (SD = 2.40)

Stimuli
Hand clap video + sound of a hand clap or 100 different environmental sounds (e.g. a doorbell or a car horn)

Experimental conditions

1. NATURAL timing of hand clap sound
2. RANDOM-TIMING of hand clap sound -250 to 320 ms relative to visual onset
3. RANDOM-IDENTITY of 100 different environmental sounds with natural timing

88% regular visual-auditory trials 1232 / condition
12% sound omission (silent) trials 168 / condition^[3]

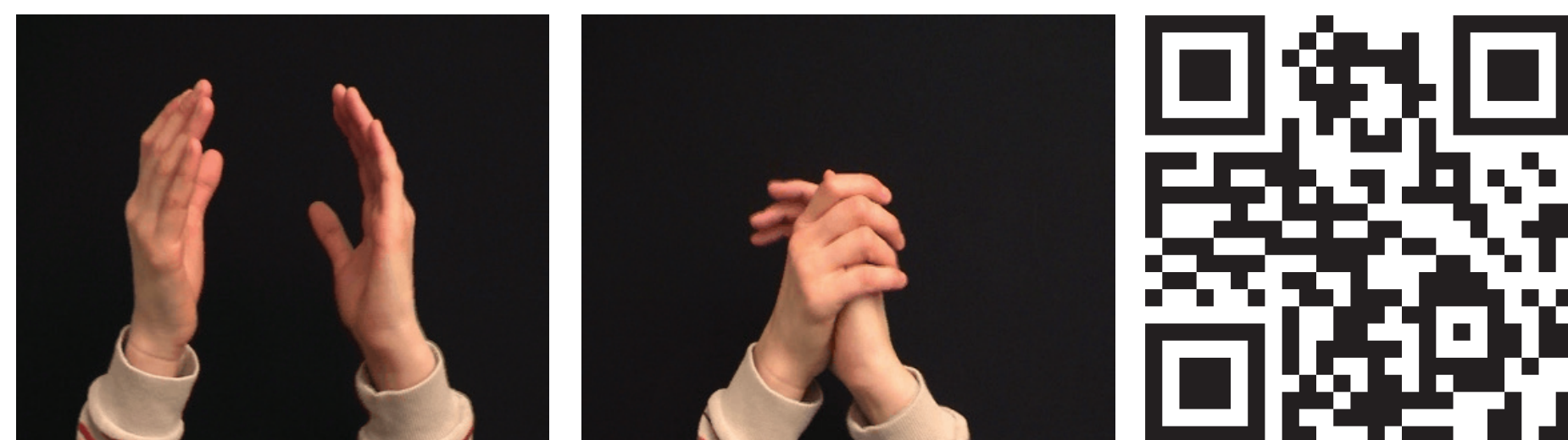


Figure 1. Screen capture of the video used in all experimental conditions

scan for VIDEO

Results

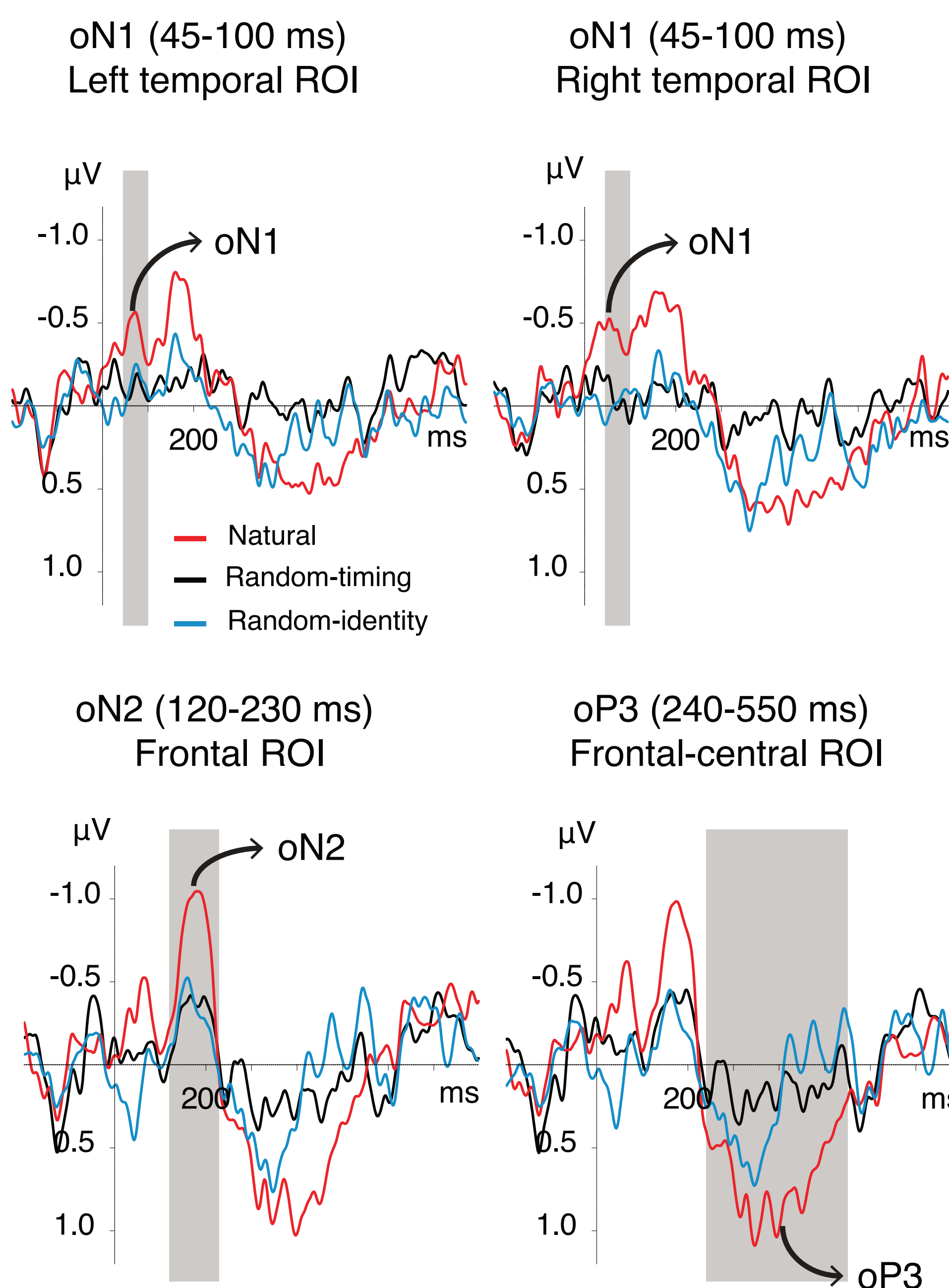


Figure 2. Direct comparison of the grand average omission-ERPs recorded at the regions of interest (ROI) showing maximal activity in the denoted time-windows. Omission responses were corrected for visual activity via subtraction of the visual-only waveform and collapsed over electrodes in each ROI.

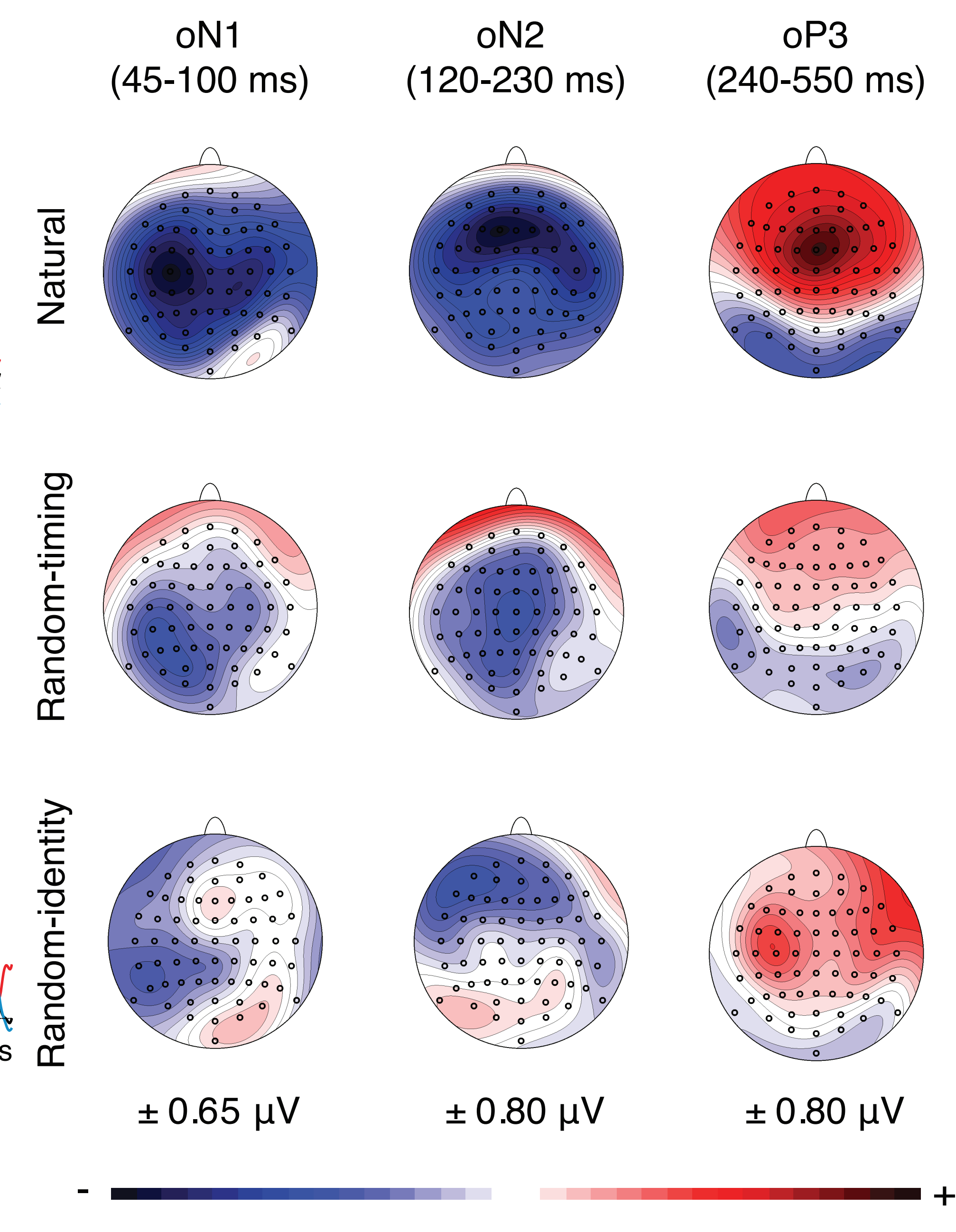


Figure 3. Scalp potential maps of the grand average visual-corrected omission responses.

Conclusions

Relative to a natural context with correct auditory timing and identity, the oN1 and subsequent oN2 and oP3 components were abolished when either the timing or the identity of the sound could not be predicted reliably from the video.

This indicates that precise predictions of *timing* and *identity* are *both* essential elements for inducing an oN1, oN2 and oP3.

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